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II. Solution by WILLIAM HOOVER, A. M., Ph. D., Professor of Mathematics and Astronomy, Ohio University, Athens, Ohio, and OTTO CLAYTON, Fowler, Ind.

If m be the tangent of the angle which the normal makes with the axis of x, the normal is given by

$$y=mx-pm-(\tfrac{1}{2}p)m^3 \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1).$$

This passing through (a, b) gives

$$b=am-pm-(\tfrac{1}{2}p)m^3 \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2),$$

a cubic in m, showing that the required number is three.

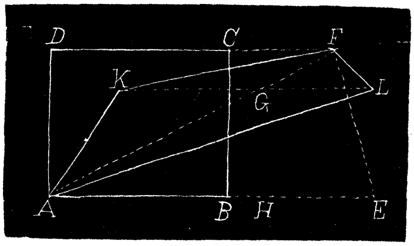
Also solved by *G. B. M. ZERR* and *J. F. LAWRENCE.*

79. Proposed by JOHN MACNIE, Professor of Mathematics, University of North Dakota, University, N. D.

To construct a quadrilateral of given area, the diagonals, one of which is given, cutting each other in given ratios and at a given angle.

I. Solution by JAS. F. LAWRENCE, Freshman Class, Classical Course, Drury College, Springfield, Mo., and the PROPOSER.

Let AC be a rectangle equivalent to the given area and having a side AB equal to one-half of the given diagonal. Produce AB to E, so that $BE=AB$; at A construct $\angle EAF$ equal to the angle to be made by the diagonals, and let AF meet DC produced in F. Divide AF in G in the ratio of division of one diagonal, and AE in H, in the ratio of the given diagonal. On an indefinite line drawn through G parallel to AB lay off GK, CL, equal to AH, HE, respectively, and FK, FL, AK, AL; $AKFL$ is the required quadrilateral.



Join EF. $\triangle FAE \simeq AC$. It is also equivalent to $AKFL$; for each is equivalent to one-half the parallelogram formed by drawing parallels through the extremities of the diagonals AF, LK.* Hence $AKFL \simeq AC$; it has also a diagonal $KL=AE=2AB$; its diagonals also are divided in the given ratios, and make an angle $FGL=\angle EAF=$the given angle. Hence, etc.

II. Solution by G. B. M. ZERR, A. M., Ph. D., Lebanon, Va.; OTTO CLAYTON, Fowler, Ind.; and F. R. HONEY, Ph. B., New Haven, Conn.

Let AB be the given diagonal, COB the given angle, $\triangle$ the given area, $m : n$ the given ratio for the known diagonal, $p : q$ the given ratio for the unknown diagonal.

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*From the well known theorem: Any quadrangle is equivalent to one-half the parallelogram formed by drawing lines through its vertices parallel to its diagonals; follow the corollaries—

a. Two quadrangles are equivalent if their diagonals are respectively equal and intersect at the same angle. (Triangle a special case.)

b. Any quadrangle is equivalent to the rectangle of its diagonals multiplied by half the sine of their angle.

Let x=unknown diagonal, $\beta=\angle COB$, h=altitude of triangle above AB, h_1=the altitude of the triangle below AB, a=given diagonal.

$$x=2\triangle/a\sin\beta \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1).$$

Divide AB at O in ratio $m:n$ and draw the indefinite line KL making an angle β with AB.

Let $CO=p$, $DO=q$, $OK=y$, $OL=z$.

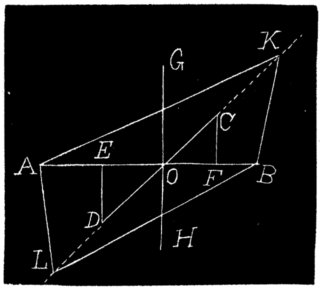
$$\therefore\; y=xp/(p+q)=2p\triangle/\{a(p+q)\sin\beta\},$$

$$z=xq/(p+q)=2q\triangle/\{a(p+q)\sin\beta\}.$$

$$\therefore\; h=2p\triangle/\{a(p+q)\}$$

$$h_1=2q\triangle/\{a(p+q)\}.$$

Draw OG, OH perpendicular to AB and $=h$, h_1; draw GK, LH parallel to AB, cutting KL in K and L. $\therefore$ $AKBL$ is the quadrilateral.



III. **Solution by A. H. BELL, Hillsboro, Ill., and F. R. HONEY, Ph. B., New Haven, Conn.**

Let a, and b, equal the segments of the given diagonals.

Let $x+y$, and $x-y$, equal the segments of the other diagonals.

Let r=the given ratio of the later diagonal, and θ the angle. Then

$$\frac{x+y}{x-y}=r \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1).$$

Also, $ax\sin\theta+bx\sin\theta=c$ the given area ....(2).

$$\text{(2) and (1)}\; x=\frac{c}{(a+b)\sin\theta}=\frac{r+1}{r-1}y \;\ldots\ldots\ldots\ldots\ldots\ldots (3).$$

$$y=\frac{c(r-1)}{(a+b)(r+1)\sin\theta},\quad x+y=\frac{2cr}{(a+b)(r+1)\sin\theta},\quad x-y=\frac{2c}{(a+b)(r+1)\sin\theta}.$$

Now having all the segments of the two diagonals with the given angle between them, the construction of the required quadrilateral is very simple.

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MECHANICS.

Conducted by B. F. FINKEL, Springfield, Mo. All contributions to this department should be sent to him.

SOLUTIONS OF PROBLEMS.

52. **Proposed by S. ELMER SLOCUM, Union College, Schenectady, New York.**

A chain 16 feet long is hung over a smooth pin with one end 2 feet higher than the other end and then let go. Show that the chain will run off the pin in about 7-5 second. [*Wright's Mechanics*, page 92.]